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A quantum accurate waveform synthesizer as a voltage reference for an electronic primary thermometer ALESSIO POLLAROLO, SAMUEL BENZ, HORST ROGALLA, PAUL DRESSELHAUS, NIST — We are using a quantum voltage noise source (QVNS) for use as an intrinsically accurate voltage reference for a new type of electronic temperature standard. In Johnson Noise Thermometry (JNT) the noise of a resistor is used to measure temperature or Boltzmann's constant k, because the Nyquist equation $<V^2>=4kTR\Delta f$ shows that the power spectral density $<V^2>$is proportional to k, temperature T, resistance R and measurement bandwidth Δf. The QVNS is a digital to analog converter used to synthesize a voltage waveform that resembles pseudo-random noise comparable in amplitude to the resistor noise. The signal generated is a frequency comb of harmonics tones that are equally spaced in frequency, all having identical amplitudes but random phases. The QVNS is an array superconducting Josephson junctions that are biased with a pulsed waveform clocked at 10 GHz. The accuracy of the voltage waveform derives from the identical voltage pulses produced by each junction that are perfectly quantized because their time-integrals are always equal to flux quantum $h/2e$. The time-dependent output voltage waveform is determined by the number of pulses and their density in time. The measurement electronics exploits cross-correlation techniques to reduce the uncorrelated measurement noise so as to reveal the resistor noise, both of which are on the order of 2 nV/$\sqrt{\text{Hz}}$. With this technique we have measured k with an uncertainty of about one part in 10^5, which we hope to improve by another order of magnitude with further research.

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